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Final Report

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Surface Energy Budget and Evapotranspiration Measurement Support

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One of the primary aims of the Convection and Precipitation/Electrification (CaPE) experiment held on the Kennedy Space Center (KSC) during the summer of 1991 was to correlate the sensible and latent heat flux from the vegetation canopy on Merritt island with satellite imagery of the development and maturation of the thunderstorms which grow over KSC. The sensing systems which were used to collect surface observations of radiation, sensible heat flux, latent heat flux, and soil heat flux at two locations on Merritt Island were acquired and assembled as a part of this grant. The observing systems which were built are called Surface Radiation and Energy Budget Systems (SREBS) and are integrated observing platforms comprised of five sub-systems. The five sub-systems and their capabilities are:

1) The Bowen ratio sub-system

Measures the temperature and moisture gradients immediately above the canopy.

2) The radiation sub-system

Measures the long and short wave radiation reaching the surface from the atmosphere and sun, and the long and short wave radiation being being emitted and reflected by the canopy

3) The soil sub-system

Measures the soil temperatures at four different levels down to 40cm, the heat flux through the soil surface to the surface, and the soil moisture at two levels.

4) The meteorological sub-system

Measures the standard meteorological variables of pressure, temperature, relative humidity, rainfall, wind speed and direction.

5) The electronics sub-system.

Monitors the inputs from the sensors described above, using a micro-processor-controlled data logger, a Campbell Scientific model CR-7. The CR-7 programming module also calculates nominal statistical quantities. A standard cassette recorder is interfaced with the data logger for permanent storage.

A complete description of an SREBS can be found in Smith et. al. (1992).

Using both of the SREBS assembled under this grant (figure 1), we have obtained a complete picture of the distribution and partitioning of the various components in the surface energy budget at two sites during CaPE. An example of the kinds of data recorded by the SREBS during the experiment is shown in figures 2-5. The equipment was assembled from scratch and tested in Tallahassee before deployment in the field at KSC.

Assuming responsiblity for archiving GOES satellite data obtained by FSU during the CaPE experiment was also a part of the proposal. The field experiment plan required that infrared, visible and water vapor channel data be retrieved and stored every half hour, 24 hours a day, for the duration of the campaign. In order to accomplish this, an OS/2 ingestor PC had to be re-programmed to sectorize the full disk GOES imagery that we recieve every half hour from our Direct Readout Ground System (DRGS). In addition to the archiving, a written log was kept, describing weather conditions observed in the satellite imagery. This record is now proving to be quite helpful in our

current analysis of the CaPE data, in which we are defining operational days in terms of the degree to which they were disturbed by large-scale weather systems. The satellite data were archived on an MOD, and recorded on magnetic tape as a backup. Satellite imagery was archived every half hour, 24 hours a day, during the experimental period. An example of the archived visible imagery is shown in figure 6.

The SREBS deployment took place on time, and the archiving process was carried out smoothly and successfully. The satellite data that was archived has aleady been used to provide the basis for one publication (see Cooper and Smith, 1992), and is proving to be invaluable in assessing the nature of the overall meteorological conditions under which the SREBS observations were taken. The SREBS data which were obtained are currently being analyzed as part of the graduate thesis of Mr. Michael Rubes.

Ms. Ann Yersavitch, a summer Space Grant student at FSU, participated in the Annual Meeting of the National Society of Engineering Science, which was held in Gainesville, Florida in November of 1991. She presented a poster which used data collected by the FSU satellite reciever and the FSU SREBS systems deployed on Merritt island under this grant, to describe the conditions surrounding the launch of the space shuttle Atlantis. Her daily description of the meteorological conditions surrounding the Cape as seen from the GOES satellite and a detailed compilation of the kinds of data she archived for the project can be found in the report "FSU GOES Satellite Data Archive for the NASA CaPE Project", by Ann Yersavitch and E.A. Smith, which can be obtained from FSU.

References

Smith, E. A., W. L. Crosson, and B. D. Tanner, 1992: Estimation of surface heat and moisture fluxes over a prairie grassland. Part 1: *In situ* energy budget measurements incorporating a cooled mirror dew point hygrometer. J. Geophys. Res., in press.

Cooper, H. J., and E. A. Smith, 1992: The importance of short term forecasting of thunderstorms to launch operations at Cape Canaveral. Submitted to Bull. Am. Met. Soc.

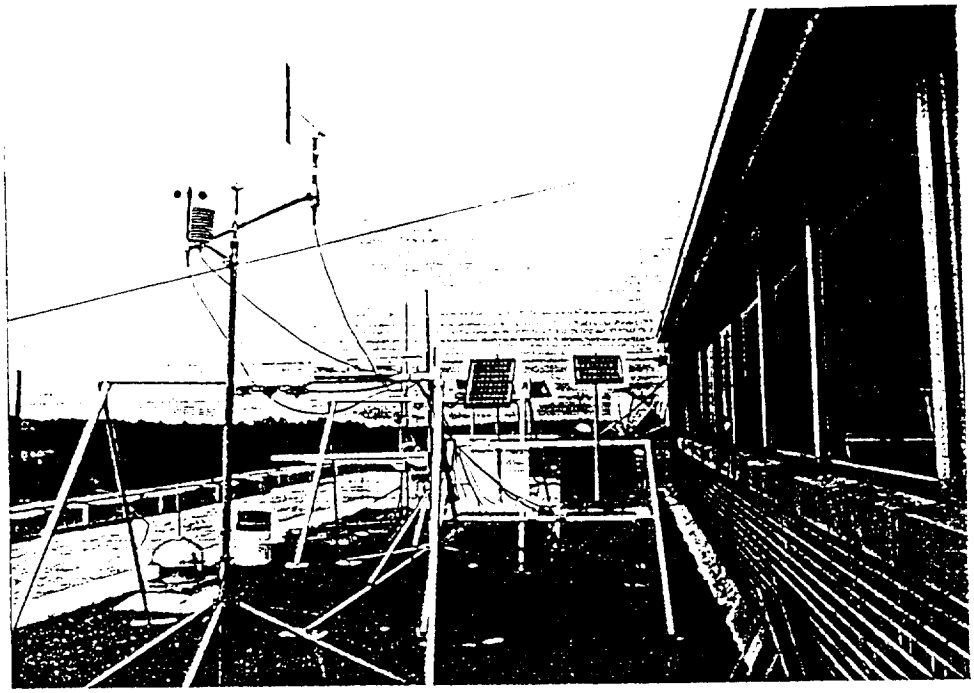

Figure 1 (a) Assembling the Surface Radiation and Energy Budget Systems (SREBS) in Tallahassee

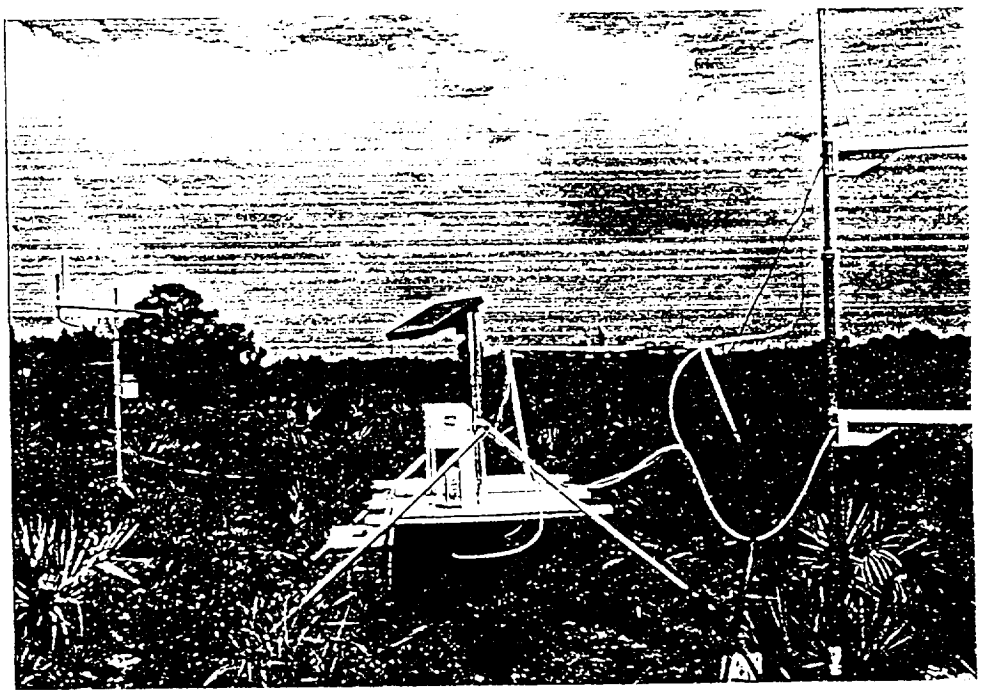

Figure 1 (b) One of the FSU SREBS as it was deployed at the North site on Kennedy Space Center during CaPE

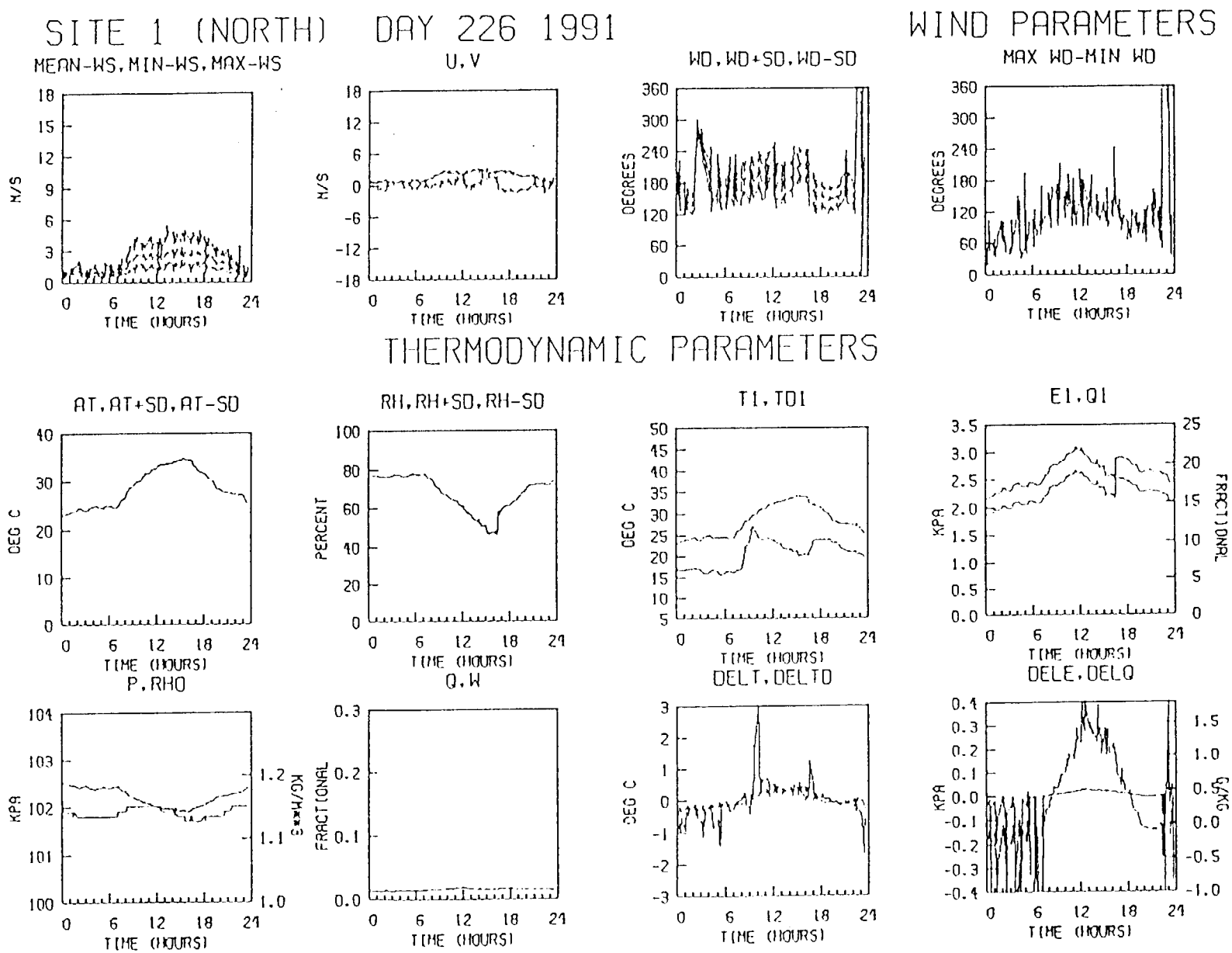

Figure 2 Some of the meteorological and thermodynamic parameters calculated by the FSU SREBS deployed at the North site on Merritt Island

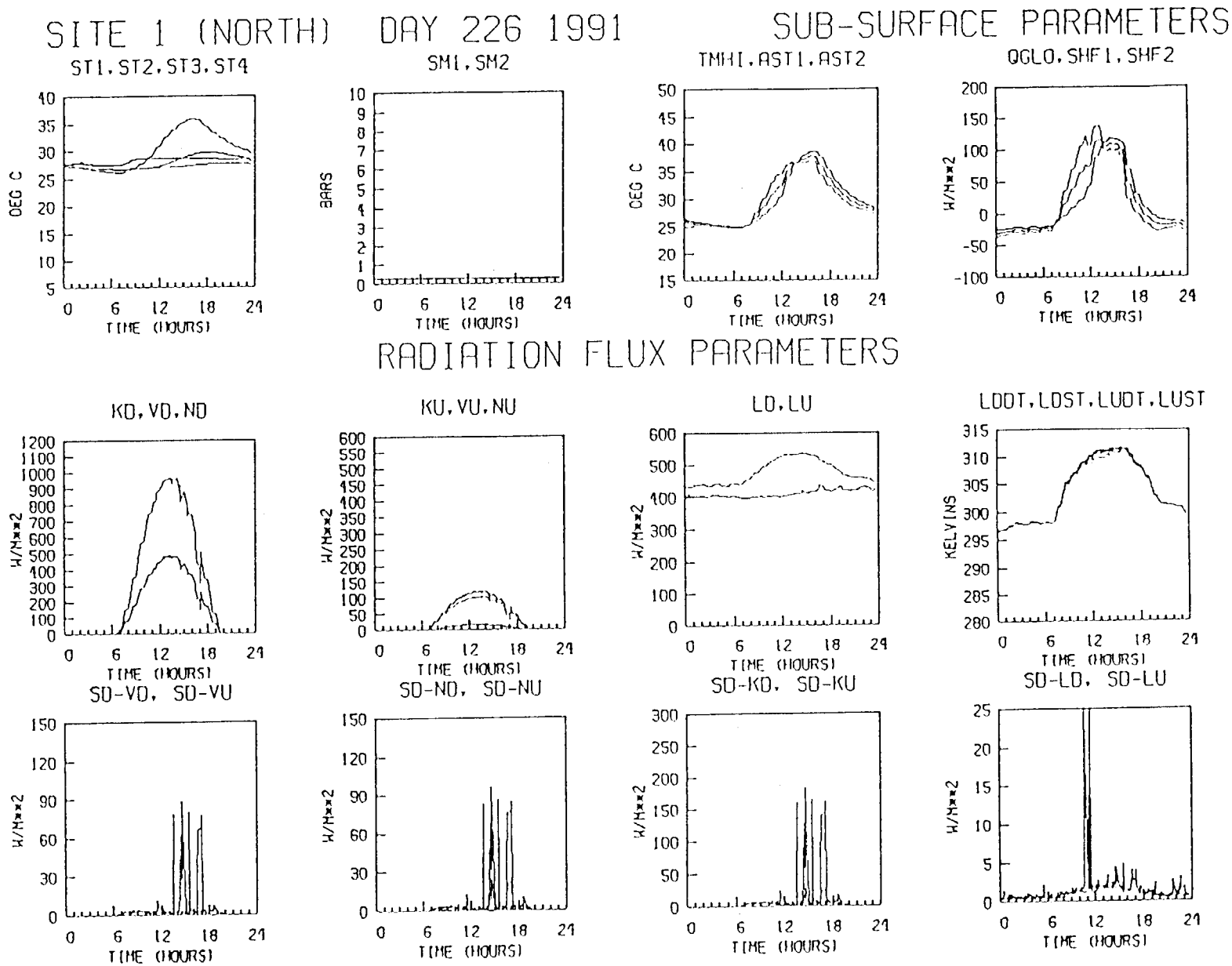

Figure 3 Some of the sub-surface and radiation parameters calculated by the FSU SREBS deployed at the North site on Merritt Island

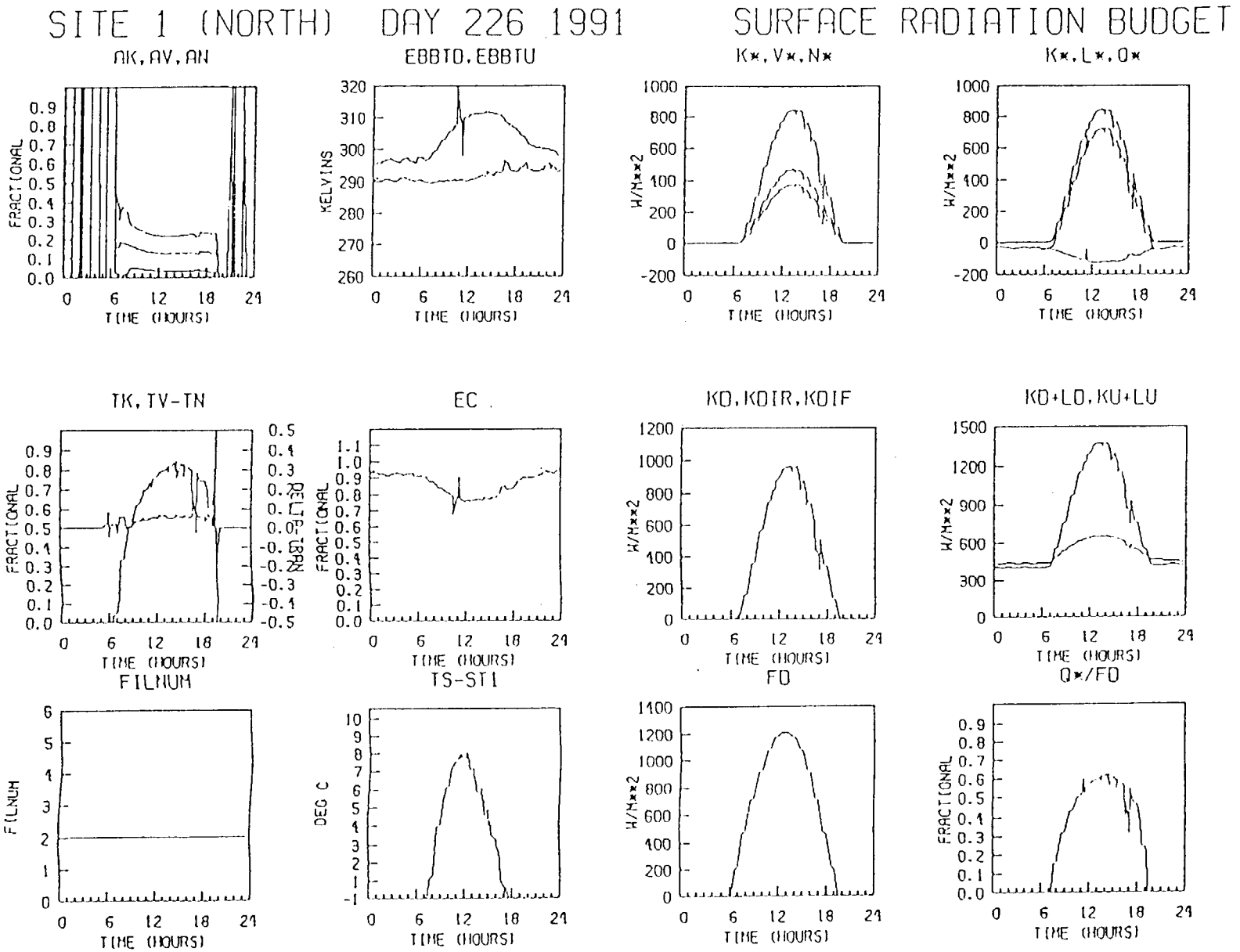

Figure 4 Some of the surface radiation budget parameters calculated by the FSU SREBS deployed at the North site on Merritt Island

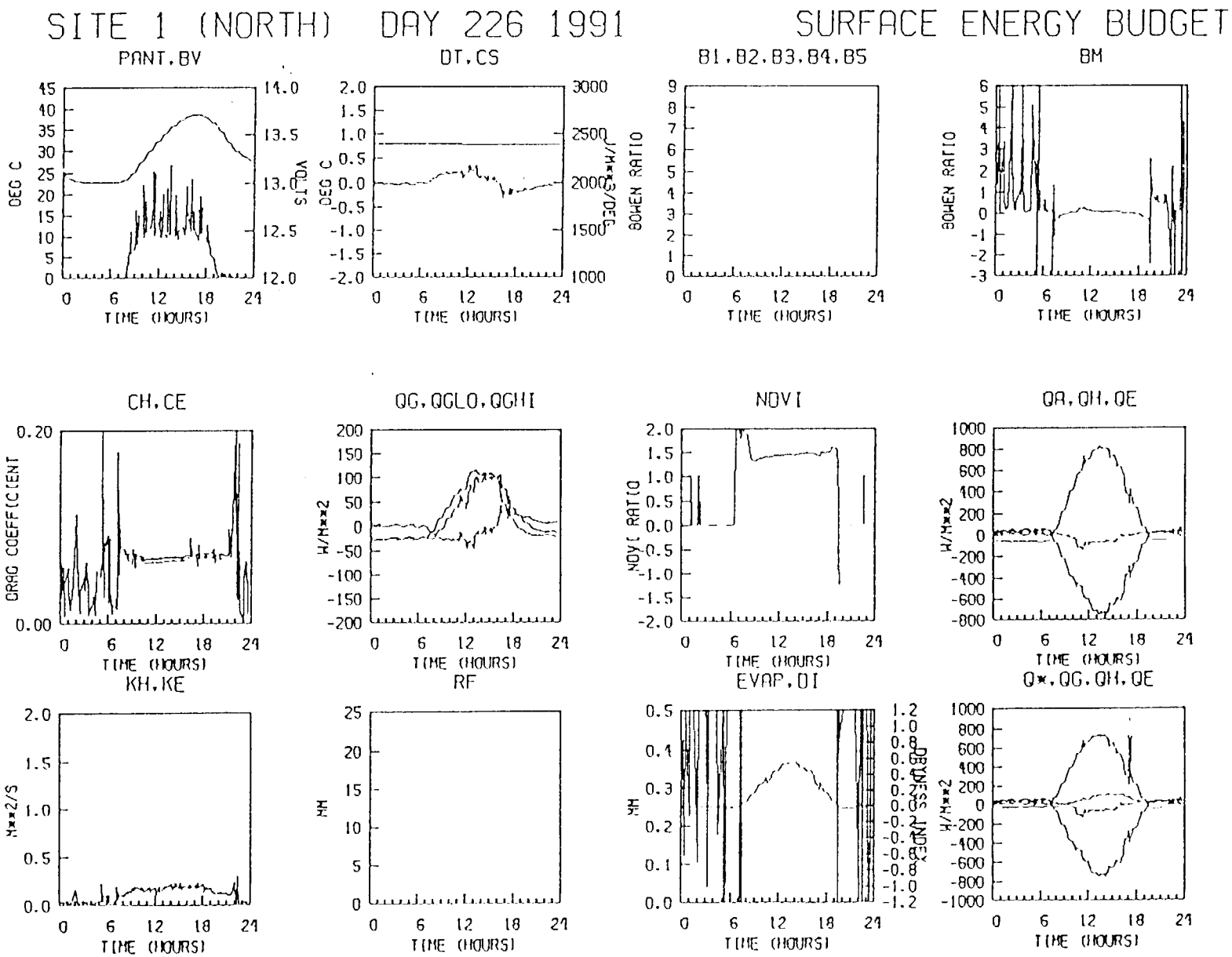

Figure 5 Some of the surface energy budget parameters calculated by the FSU SREBS deployed at the North site on Merritt Island

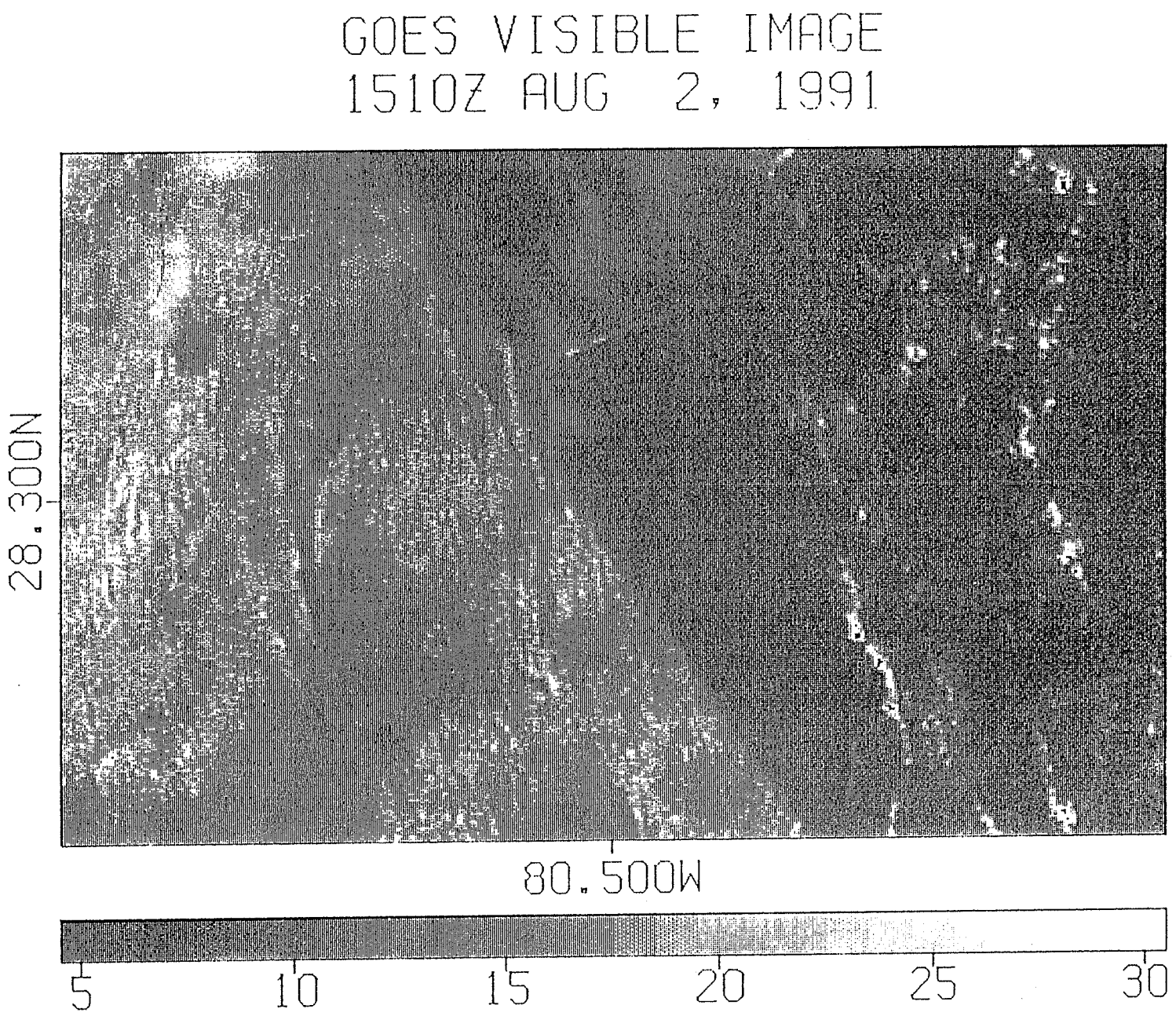

Figure 6 The GOES visible image archived at FSU for CaPE on August 2, 1991 during the launch of the space shuttle Atlantis.